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THIRD QUARTERLY PROGRESS REPORT

PRODUCTION ENGINEERING MEASURE FOR THE MANUFACTURE OF DEFLECTRON DEVICES

November 14, 1962 - February 14, 1963

Contract # DA-36-039-SC86731
Order No. 19053-PP-62-81-81

U. S. Army Signal Supply Agency
225 South 18th Street
Philadelphia 3, Pennsylvania

PICKUP TUBE OPERATION
POWER TUBE DEPARTMENT
GENERAL ELECTRIC
Syracuse, N. Y.

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OBJECT: To establish and prove the capability for producing production quantities of Deflectron cathode-ray tube types.

U. S. Army Signal Supply Agency
225 South 18th Street
Philadelphia 3, Pennsylvania

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I. ABSTRACT

This is the third quarterly report describing the progress of the "Production Engineering Measure" under Signal Corps Contract DA 36-039 SC-86731 for the period ending February 14, 1963.

A redesign of the basic master for the CY1.1-33° has been satisfactorily completed. Ceramic substrate cones for the model Deflectron were put in process. A study for determining a technique for fastening electrode pins in the ceramic cones was initiated and completed.

The adaptation of the vacuum-metallizing technique for manufacturing Deflectron units continues.

II. PURPOSE OF THE PROGRAM

A device known as the "Deflectron" has been developed under Signal Corps Contract DA-36-039-SC-64614. The Deflectron performs the function normally assigned to the two sets of deflection plates standard to electrostatically deflected cathode-ray indicator tubes.

Three Deflectron types have been selected to represent the most probable applications for the device. The Co4-86° wide angle (Illustration A), Co4-66° medium angle (Illustration B), and CY1-33° narrow angle (Illustration C) are described and evaluated in the final report of the above-mentioned contract.

Limited quantities of this device have been prepared under laboratory conditions by the Pickup Tube Operation of the Power Tube Department, General Electric Company. The need for the successful manufacture of production quantities of the Deflectron led to the award of the "Production Engineering Measure", Contract No. DA 36-039 SC-86731, to General Electric on May 14, 1962.

The progress of this program during the third three-month period is described in the following sections.

III. DESCRIPTION OF THE MANUFACTURING PROCESS

A completely satisfactory and workable process has been devised and presently is used for preparing Deflectron units in limited quantities. This process, utilizing a silvering and photoresist technique, is shown in Illustration D, Process Flow Diagram (Deflectron Devices by Silvering and Photo Etch Technique).

An alternate technique, whereby the silvering process is replaced by a less troublesome vacuum-metallizing procedure, has proven satisfactory and was proposed as the operating process for this program. This technique is illustrated fully in the Process Flow Diagram (Deflectron Devices by Evaporation Technique), Illustration E. A thin, conductive film is vacuum-evaporated onto the substrate through an evaporation master etched with the desired Deflectron pattern.

Both of the above-mentioned techniques have provided satisfactory performance in completed tubes.

The need for determining and implementing the most desirable manufacturing process led to the appraisal of alternate methods for preparing these devices. An approach whereby the conductive elements are free-floated, or suspended without the use of a substrate, underwent evaluation. This free-electrode approach, which incorporates methods in parts fabrication along with the use of photoresists and metal etchants, has been developed and proven feasible under this

III. DESCRIPTION OF THE MANUFACTURING PROCESS

contract. Sample units have been prepared in this manner with a completed tube, Z4844, incorporating this device, having been manufactured and tested to specification.

The "free-electrode" system (See Process Flow Diagram, "Deflectron Devices by Free-Electrode Approach", Illustration F) was originally developed as an alternate or back-up process for the proposed vacuum-metallizing technique. As the work progressed, however, it was found that these same methods were applicable in preparing evaporation masters necessary in the proposed approach. For this reason, considerable effort has been devoted to perfecting this technique.

IV. MAJOR PROBLEMS AND CORRECTIVE ACTIONS

The proposed process for manufacturing Deflectron units by a vacuum-metallizing technique is described in Section II. In an effort to perfect this process and adapt it to manufacturing procedures, a number of problems have been encountered.

A. Redesign of Master Configuration

Original masters for the cylindrical CY1-33° were prepared from straight-walled beryllium-copper tubing. It became apparent during the evaluation of the evaporation technique that the configuration should be changed from a cylinder to a slight-taper cone to provide better contact between master and substrate and thereby facilitate the manufacture of the parts.

The first modification was carried out by photographically distorting the original acetate master. An evaporation master was prepared from this design, but it soon became apparent that certain inaccuracies were inevitable in utilizing this distortion technique.

A complete redesign of the acetate master was made during this reporting period by drafting a four-to-one enlargement, incorporating the necessary design changes. The results of this work are presently under evaluation.

B. Procure Evaporation Masters

The proposed evaporation technique requires the use of properly designed evaporation masters. As stated in previous

IV. MAJOR PROBLEMS AND CORRECTIVE ACTIONS (Continued)

reports, original evaporation masters for the cylindrical CY1-33° model were made by utilizing a photo-etch technique. For manufacturing purposes, a change from the cylindrical model to the slightly tapered CY1.1-33° led to the use of an electroforming approach for the production of these masters. The above-mentioned work was performed by the Buckbee-Mears Company of St. Paul, Minnesota. An additional source, Beemer Engineering, subsidiary of the Chemical Micro Milling Company, has submitted a proposal for fabrication of these same parts.

Initial evaporation masters were prepared by etching only one half of the pattern in order to provide for extra strength in the master. This approach requires a double evaporation cycle. Since some alignment difficulties have been encountered with this configuration and additional process time is required, a single-cycle master is considered.

Considerable effort has been devoted under this program so that on-site fabrication of single-cycle evaporation masters could be made. This capability should guarantee better flexibility in timing, design, and cost. Cylindrical masters already have been prepared from stainless-steel blanks; and the most recent efforts have been devoted to application of the photo-etching process to conical-shaped, stainless-steel blanks.

These spinnings from the Tri City Metal Arts Company, Schenectady, New York, are found to vary in wall weight, which

attributes to errors in registration of the etched pattern. The effect of these variations from the original acetate master is presently under evaluation.

A master for the CY1.1-33° Deflectron prepared from a stainless-steel blank as described above is shown in Illustration G-1. A glass Deflectron CY1.1-33°, prepared by the evaporation technique, using master G-1, is shown in Illustration G-2. A ceramic Deflectron, prepared in a like manner, is shown in Illustration G-3.

C. Determination of Type and Source of Substrate Materials

Substrate cones made of #7052 glass, with Kovar leads properly inserted, currently are used. These laboratory Deflectrons are made from glass tubing shrunk over a mandril and ground to inside size. Two vendors, The Reliance Glass Company, Wauconda, Illinois, and the Wilmad Glass Company, Inc., Buena, New Jersey, have been contacted; and quotes for various quantities have been submitted. Completely satisfactory samples of the model CY1.1-33° have been furnished by both suppliers.

Costs for these glass parts were found to be relatively high and remain appreciably the same, even if ordered in the larger quantities required for this program.

Ceramic substrate cones are also under consideration. The Centralab Company, Milwaukee, Wisconsin; the American Lava Company, Chattanooga, Tennessee; the Coors Porcelain Company,

Golden, Colorado; and the Power Tube Department of General Electric Company, Schenectady, New York, all have been contacted and are considered as potential suppliers.

Sample parts, made of high-density alumina, from Centralab have been evaluated and were found to be dimensionally accurate, yet as much as nine times less expensive than comparable glass substrates. Ceramics also are favored for their inherent ruggedness and surface characteristics.

D. Installation of Electrode Pins in Ceramic Cones

Initial samples of ceramic parts were ordered without electrodes in order to expedite delivery. A number of techniques for properly fastening these pins were evaluated and are listed below in order of preference, based on adaptability to production, quality of seal or bond, equipment availability, and resultant costs.

Moly-manganese metallization: A process that provides a good mechanical and vacuum seal between the ceramic body and metal electrode. This technique is fully developed with necessary equipment and facilities readily available within the Department for production quantities. The process also provides a "printed-circuit" (conductive) area around the inside edges of the lead-through without disrupting the flush inside contour of the part.

Titanium Hydride - Active metal technique: This process is similar to the moly-manganese approach in that it provides

excellent ceramic-to-metal bonds, along with the "printed circuit" - flush-contour features. The process requires high-vacuum firing which limits its adaptability to production at this time.

Pyroceram-frit Technique: Easily adapted process with strong bond, but lacks the very desirable "printed-circuit" contact areas, on inside surface, which guarantee good electrical contact between the vacuum-metallized film and the electrode.

Mechanical-fastening Techniques: Numerous means for attaching electrodes by a simple mechanical operation have been considered. Swaging, crimping, and spot-welding of eyelets all stand the possibility of damage to the ceramic part and lack the good solid bond required between ceramic and electrode pin.

E. Free-Electrode Deflectrons

Considerable effort has been devoted to the evaluation of the suspended, or free-electrode, approach. The advantages and disadvantages of this approach have been discussed in the second quarterly report.

The technique utilized for the preparation of these units is identical to the process developed for the preparation of evaporation masters. See Illustration F, Process

IV. MAJOR PROBLEMS AND CORRECTIVE ACTIONS (Continued)

Flow Diagram, "Deflectron Devices - Free-Electrode Approach".

Major improvements in the process made during the last quarter included:

1. the adaptation of a more-sensitive photoresist, Eastman KOR Resist and
2. various modifications in the electro-etching materials and equipment.

A completed tube, Z4844, utilizing a "free-electrode"-type CY1-33° Deflectron, was fabricated and tested. The mount assembly is shown on page 25 , Illustration H. Test results for this tube will be compared to data for a similar tube utilizing a CY1-33° model processed in a standard manner. Results of this evaluation will be published in the next quarterly report.

V. PRODUCTION OF DEFLECTRON UNITS

Limited quantities of the model CY1-33° have been produced by laboratory personnel, using laboratory equipment and techniques. See Illustration D, Process Flow Diagram (Deflectron Devices by Silvering and Photo Etch Technique).

It is the aim of the General Electric Company to provide a facility for and to prove the capability of manufacturing each of the three Deflectron models at the rate of 20 units per day as prescribed by the contract.

VI. FACILITY

Three indicator-tube types (Z4842, Z4843, and Z4844), utilizing the various models of the Deflectron, have been chosen as vehicles for testing and evaluation of the device. Because these parts are unique to the standard indicator line of tubes, a separate facility for producing the Deflectron units will be provided.

An area of 200 square feet has been reserved for use as a processing area for these units. It is being planned that the facility will be entirely self-sufficient with its own complement of necessary personnel and equipment.

The location of the Deflectron processing area was chosen to facilitate the use of existing Indicator and Pickup Manufacturing facilities wherever applicable. It is contemplated that all screening, aluminizing, mount-making, and tube-finishing operations will be performed on equipment commonly used in producing the standard indicator-type tubes. Testing and evaluation will be performed in the Section's Design Engineering Test Laboratory.

Illustration I, Flow Diagram for Production of Indicator Tubes, lists all of the tube manufacturing processes and illustrates the proper sequence of operations.

The proposed facility will be equipped and utilized as the design and process criteria are definitely established.

VII. PRODUCTION EQUIPMENT

As outlined in the "Plan of Action" (first and second quarters),Proposal for Funds, one Deflectron type will be used as a test vehicle to prove out the proposed manufacturing procedures. Based on vendor contact and experience in preparing the model CY1.1-33^{o}, the remaining two models should easily adapt to the same techniques. It is planned that, in addition to the laboratory equipment already in use, production equipment will be designed, procured, and installed as the program develops and techniques are established.

Equipment and tooling that require the greatest lead time are given priority. An appreciable effort has been devoted to the acquisition of suitable evaporation masters. An optimum design for evaporation equipment and tooling also has been given top priority in the program.

VIII. CONCLUSIONS

Development work continued on the adaptation of a vacuum-metallizing technique to the production of Deflectron units, as per the program.

A redesign of the CY1.1-33° master was successfully completed during this period. Evaporation masters have been prepared by the Buckbee Mears Company and the General Electric Company (on site), utilizing the latest modifications.

Ceramic substrate cones for the CY1.1-33° model have been procured and are under evaluation. Various techniques for the installation of electrode pins have been considered, with a moly-manganese metallization chosen for the program. A sample lot of ceramic cones has been processed accordingly.

Illustration J, "Progress Chart", indicates that the program is on schedule at approximately 35 per cent of completion.

IX. PROGRAM FOR THE NEXT INTERVAL

A quantity of ceramic substrate cones for the model CY1.1-33° will be ordered. Completed Deflectrons of this model will be made (evaporation technique) and evaluated thoroughly in completed tubes.

Ceramic samples for the remaining two Deflectron models, the CO4-66° and CO4-86°, will be requested from approved vendors.

All tube parts related to the production of the three prototype tubes will be procured in preproduction quantitites.

Further evaluation of the vacuum-metallizing technique will continue during the next quarter. An attempt will be made to design simple, inexpensive yet effective, fixtures and tooling for this approach. The evaluation of various configurations of tungsten filaments will continue.

Conical blanks of stainless steel and uniform wall weight will be procured for further on-site fabrication of evaporation masters. A decision will be made as to whether or not the single-cycle master is compatible with the proposed evaporation approach.

Evaporation masters for the CO4-66° and CO4-86° will be ordered during the next period. These masters, in addition to the ceramic substrates of these configurations, will be used to initiate work on adapting the evaporation technique to the remaining Deflectron models.

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X. PUBLICATIONS AND REPORTS

Monthly Status Letter #7, W. J. Noroski

Monthly Status Letter #8, W. J. Noroski

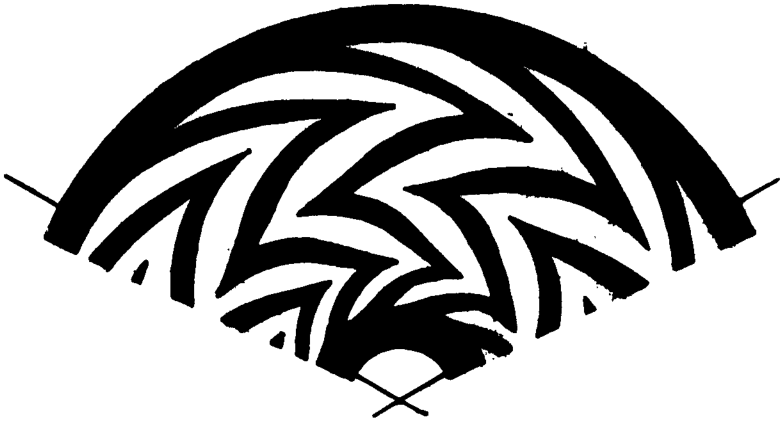
Monthly Status Letter #9, W. J. Noroski

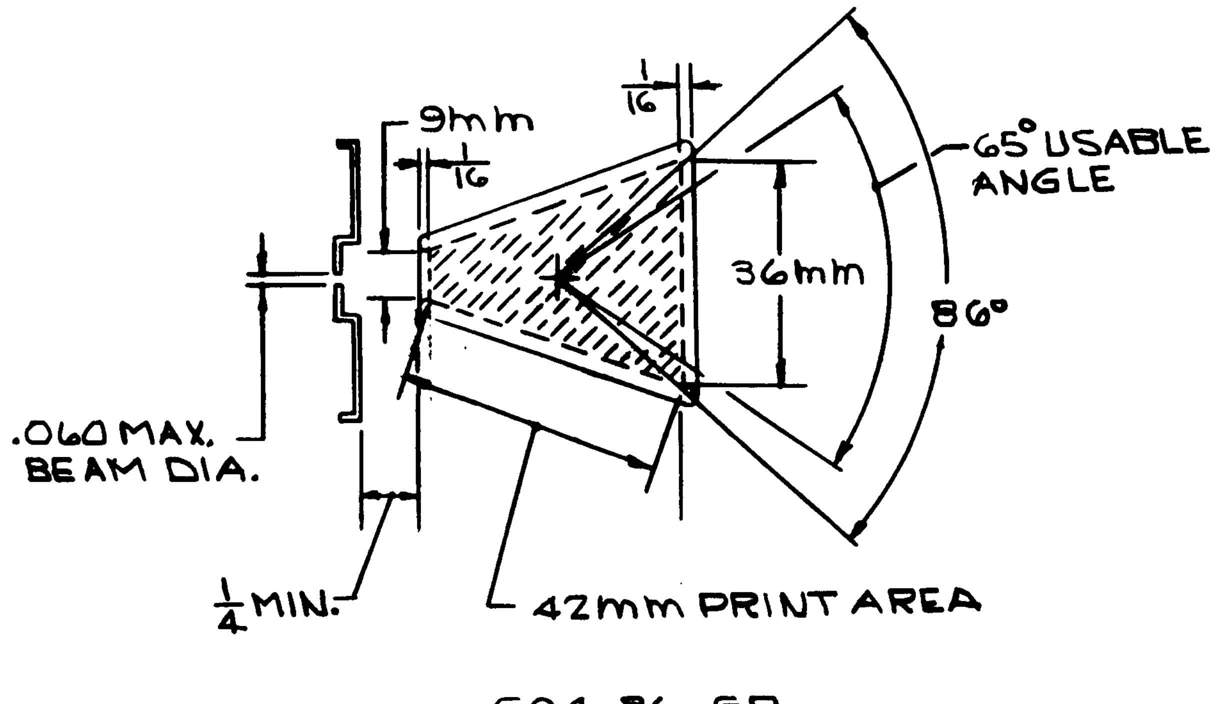
XI. PERSONNEL

A technician, Mr. L. R. Taft, has contributed to the overall program by assisting in the development of evaporation techniques required for Deflectron processing.

A reference to the table, "Manpower Hours", Illustration K, shows a 25-per-cent discrepancy between the estimated and the actual manpower hours for the first three quarters of the program.

DEFLECTRON (86°) FOR Z-4842

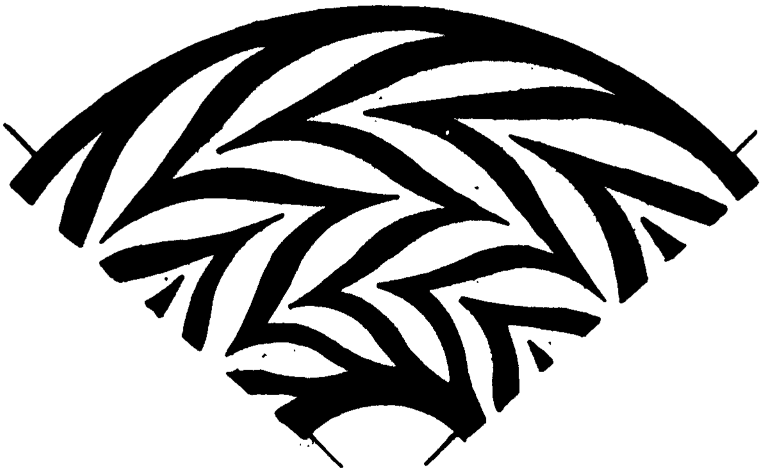


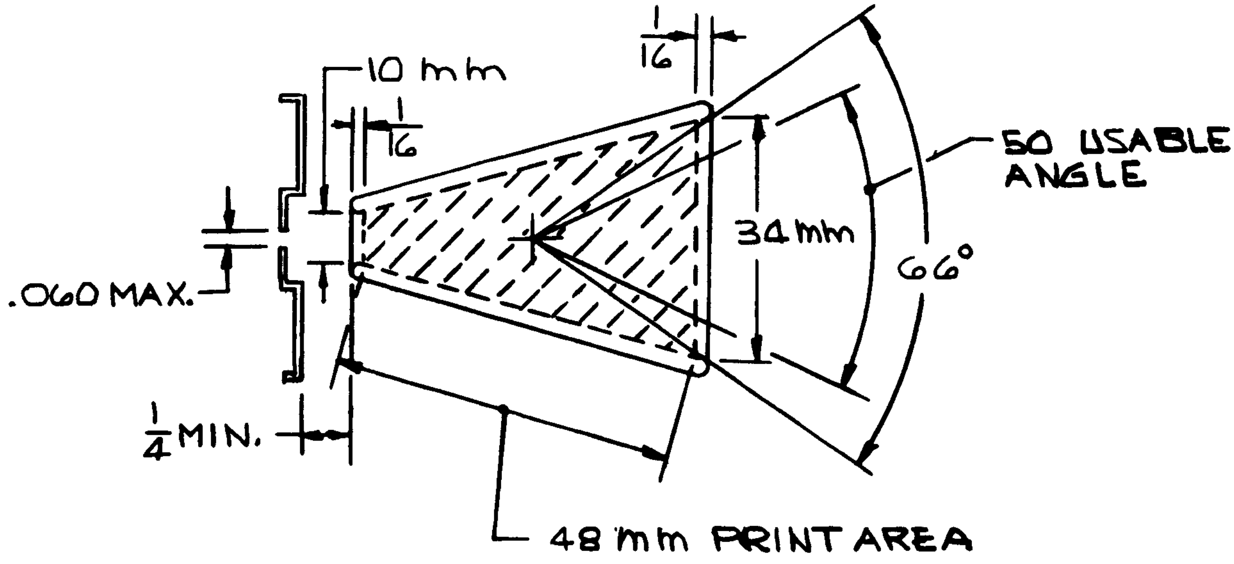


C04-86-GP
SENSITIVITY: 11.0 V/KV. DEGREE

ILLUSTRATION A

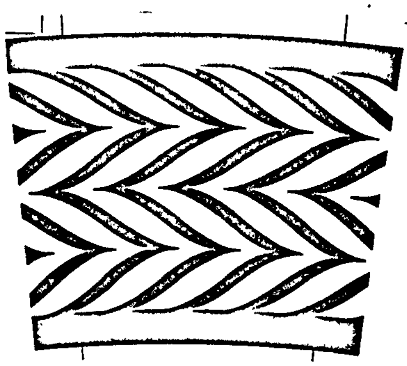
DEFLECTRON (66°)
FOR
Z-4843

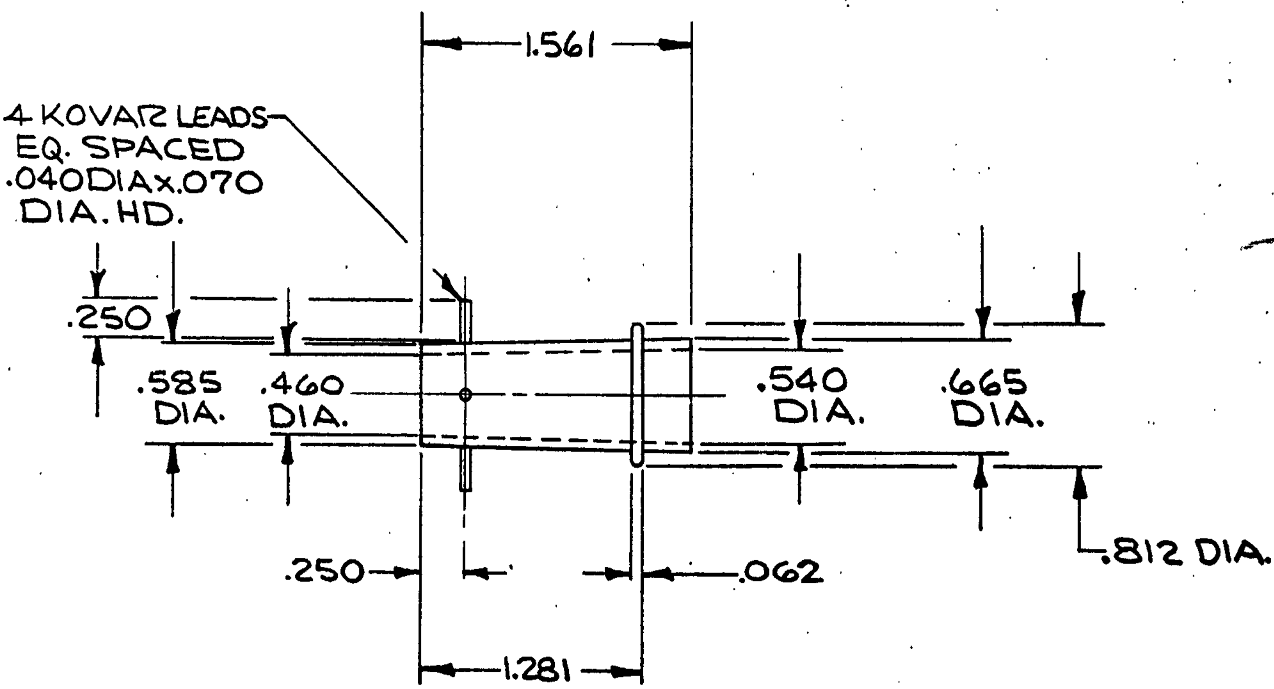




CO4-66-SIN^2
SENSITIVITY: 9.8 V/KV. DEGREE
ILLUSTRATION B

CYLINDRICAL DEFLECTRON FOR Z4844





NARROW ANGLE DEFLECTRON TYPE CY1.1-33*

SUPERSEDES TYPE CY1-33*

ILLUSTRATION C

PROCESS FLOW DIAGRAM
(DEFLECTRON DEVICES BY SILVERING & PHOTO ETCH TECHNIQUE)

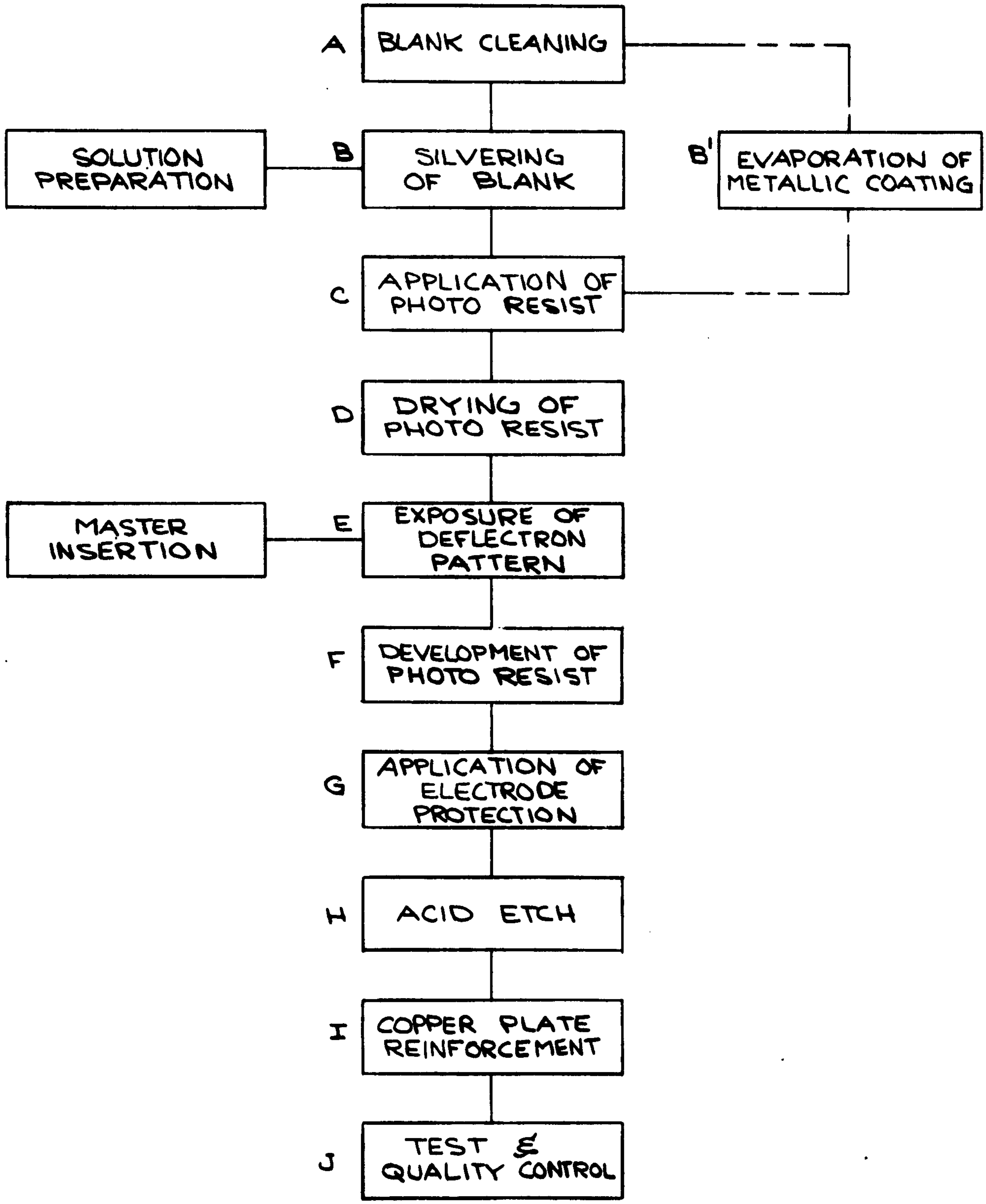


ILLUSTRATION D

PROCESS FLOW DIAGRAM
(DEFLECTRON DEVICES BY EVAPORATION TECHNIQUE)

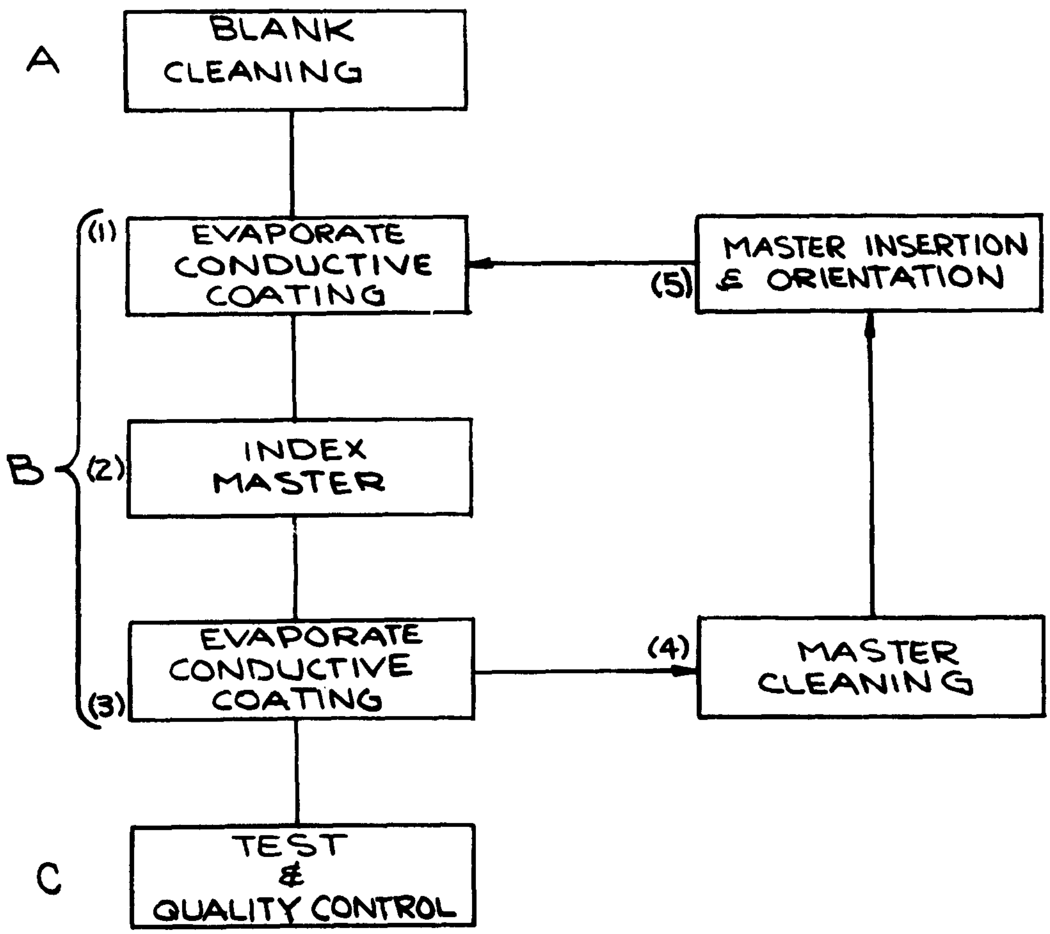


ILLUSTRATION E

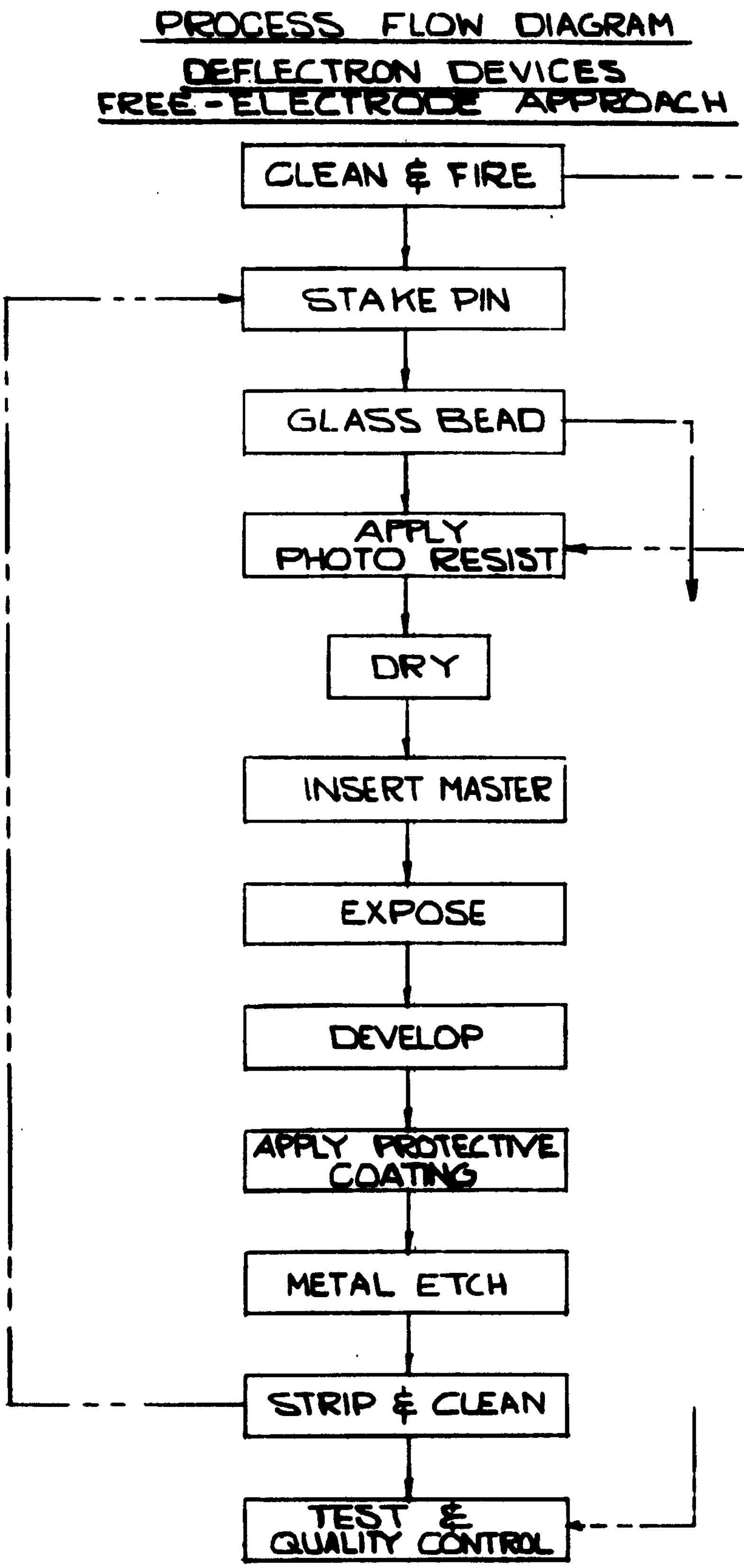


ILLUSTRATION F

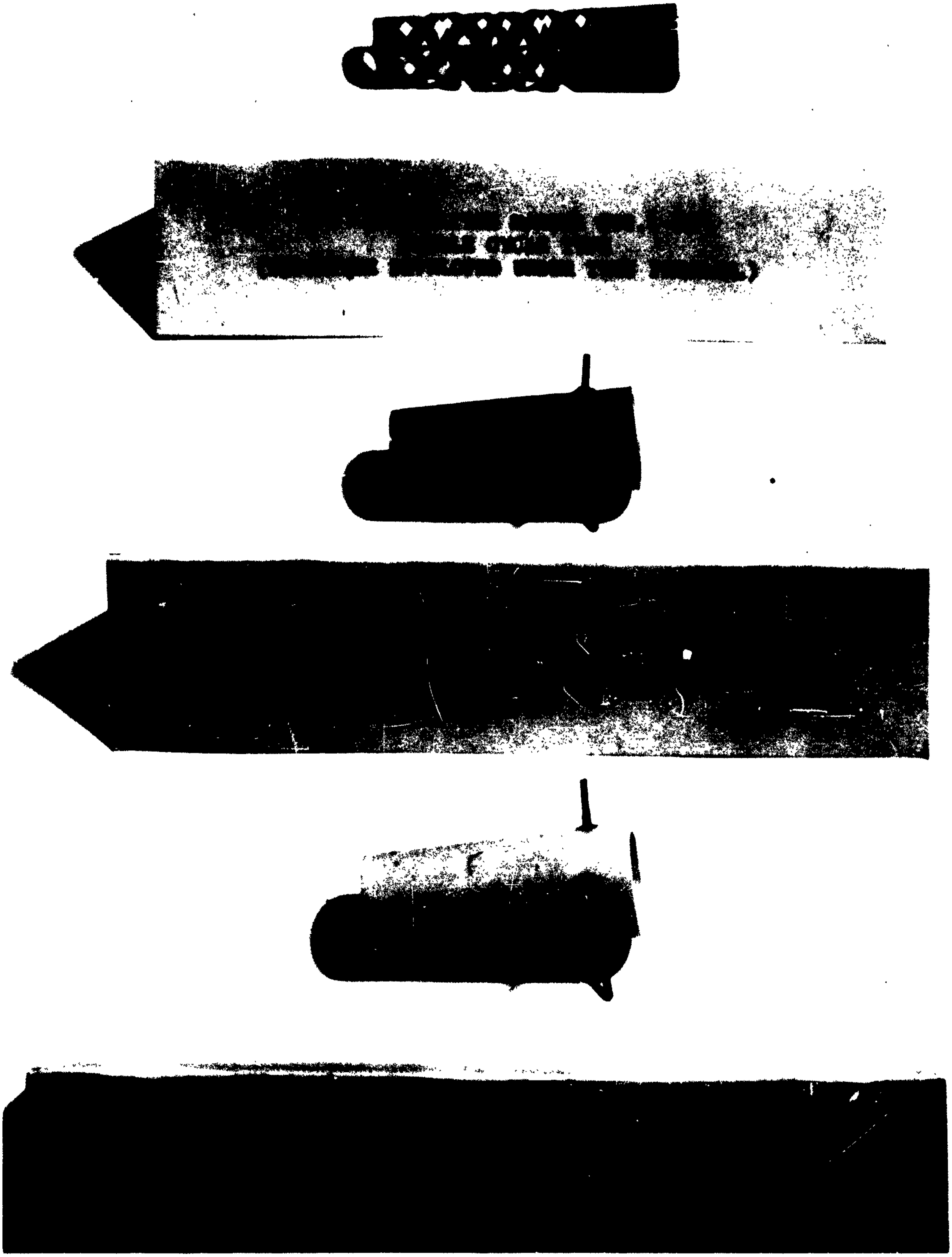


ILLUSTRATION G

ILLUSTRATION H

Mount Assembly for
Z4844 "Free-Electrode" Model CY1-33°

PROCESS FLOW DIAGRAM
(GENERAL)

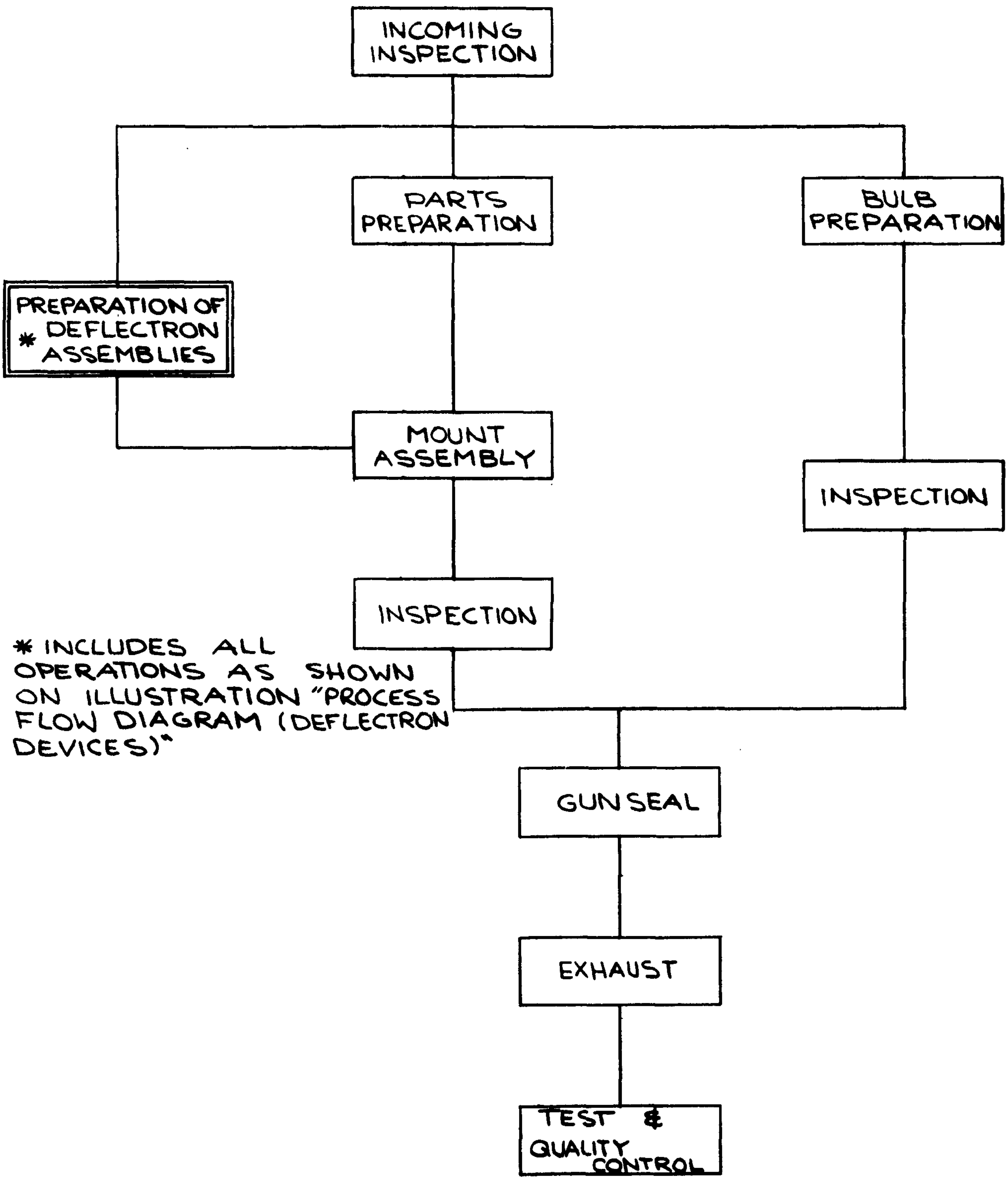


ILLUSTRATION I

PROGRESS CHART

PRODUCTION ENGINEERING MEASURE FOR DEFLECTRON DEVICES

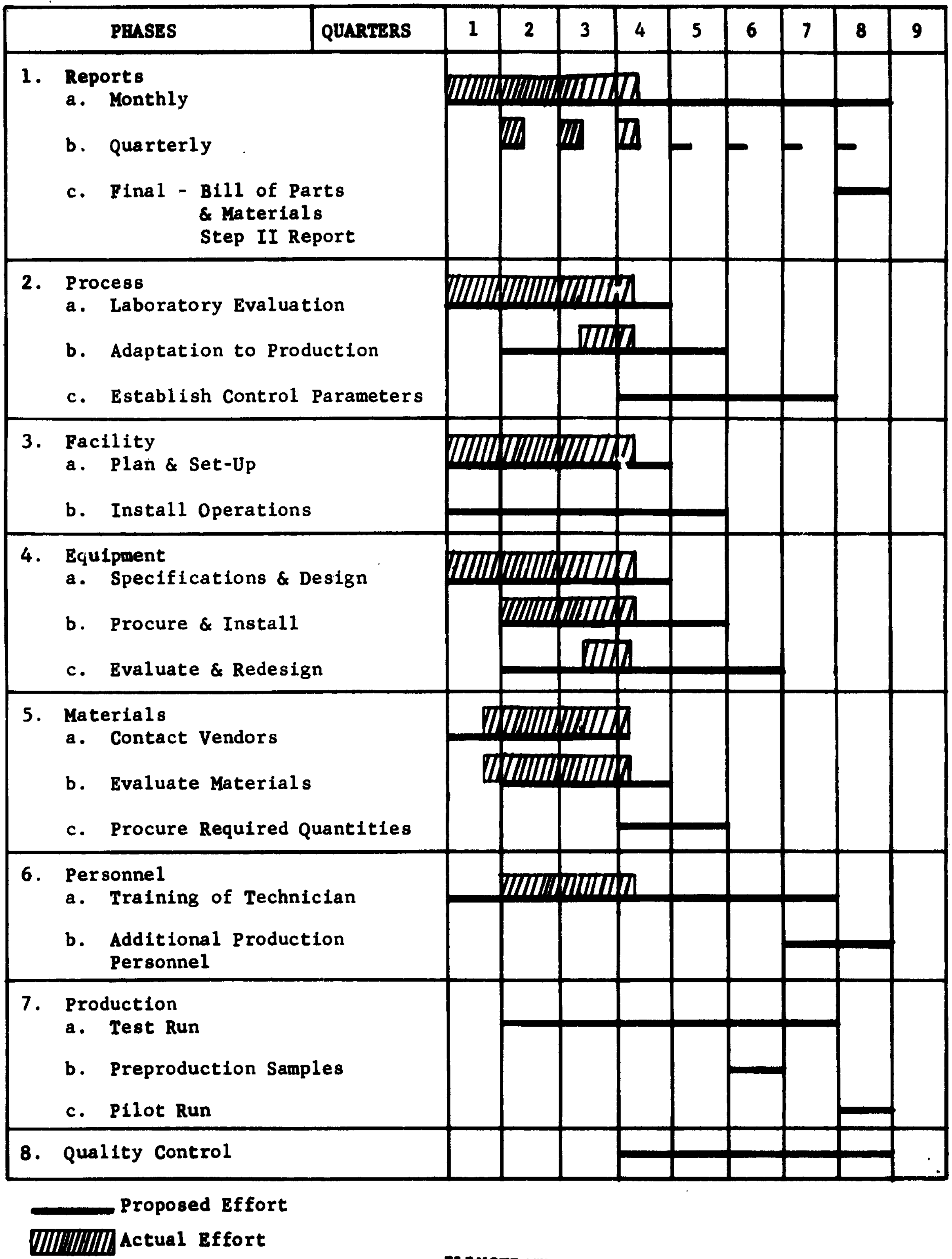


ILLUSTRATION J

ILLUSTRATION K

Manpower Hours

	First Quarter		Second Quarter		Third Quarter		Total to Date	
	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual
W. J. Noroski Project Engineer	80	85	150	236	160	173	390	494
Dr. K. Schlesinger	30	0	30	7	30	1	90	8
D. L Schaefer	15	0	15	0	5	0	35	0
M. E. Russell	0	0	10	0	0	2	10	2
Tool Designer	20	0	30	55	40	21	90	76
Draftsmen	20	2	30	38	30	7	80	47
Technician	170	10	280	346	280	107.5	730	463.5
Test Equipment Design	0	0	20	0	20	0	40	0
Manufacturing Shop	0	0	0	0	0	4	0	4
TOTAL HOURS	335	97	565	682	565	315.5	1465	1094.5

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